

school instruction had long been too bookish, too little practical, and that the friends of technical instruction were fully justified in calling attention to the grave deficiencies in our system, especially to the want of sounder teaching in physical science and of better training in the application of those sciences to the enrichment of the community and to the practical business of life.

Prof. Oscar Pyferven, of the University of Ghent, who represented the Belgian Government, read a paper on "L'Enseignement Professionnel et l'Initiative Privée en Belgique"; and M. E. Sève (Consul-General for Belgium) read a paper on "Technical and Commercial Instruction in Belgium."

Prof. Wertheimer, principal of Merchant Venturers' Technical College, Bristol, read a paper on the influence of various examining bodies on the progress of technical and commercial education in England. He held that it behoved them to watch closely any attempt to establish new examinations. The technical instruction committees of some County Councils were already instituting examinations of their own; in a very few cases these might be necessary to meet special local requirements. But, as a rule, they were not needed, and it would be wiser to endeavour to modify existing examinations, if necessary, rather than to establish new ones.

On Thursday a paper by Mr. Quintin Hogg, on "Polytechnics," was read by Dr. William Garnett, who also gave an account of the work of the Technical Education Board of the London County Council. In commenting upon the latter paper, Sir John Lubbock said that too much of the money went to the elementary and too little to the higher training of those who were to be the leaders of industry.

The next paper was on "Reforms in the Organisation of Technical Education," by Prof. Silvanus P. Thompson, F.R.S., who said that the provision made on the continent for the higher training in chemistry might be understood from the fact that the entire establishment of the Regent Street Polytechnic, chemical laboratory, gymnasium, swimming bath, theatre, cinematograph, and all, might be accommodated within the space provided for the chemical laboratory alone in the polytechnic at Munich. The chemical laboratory of the polytechnic at Zurich exceeded in contents the whole of the technical schools at the People's Palace. The chemical laboratory of Berlin was larger than the whole building of the City of London College. The physics laboratory at Zurich was considerably larger than the whole building of the Finsbury Technical College, and the cost nearly twice as much.

The remainder of the papers on Thursday dealt with commercial education, the organisation of examinations, and the development of technical instruction in secondary schools.

The concluding session of the conference, held on Friday last, was devoted exclusively to the consideration of papers by ladies on a variety of aspects of technical and secondary education. Mr. Mundella, M.P., presided.

Miss Alice Mitchell read a paper on the "Teaching of Domestic Economy in Girls' Secondary Schools." In the high schools she thought the great failure was the absence of the practical side, for all schools suffered from the want of laboratory facilities.

A paper was read by the Countess of Warwick on "Technical Education in Rural Districts." She said she had undertaken the task believing that a careful development of the subject might help not a little to stay the depopulation of our villages. An intelligent appreciation of natural phenomena and natural laws, when applied to agriculture, might go a long way to relieve the depression from which country districts were so keenly suffering. The elements of chemistry and physics, geology, botany, and zoology might be taught with great advantage to the future farmer or practical agriculturist. We should no doubt some day have a rational system of education, and not a disjointed one, as at present, when due regard would be paid to the co-ordination of subjects of instruction. At present, the great want was co-operation in all branches, but this was likely to remain while every branch of education was under a separate and distinct authority, often antagonistic to each other and encroaching on one another's grounds. In the same town they might see the voluntary schools, board schools, middle schools, grammar schools, and technical classes all being carried on under separate rate authorities, who have no regard for each other's work, and consequently overlapping each other's efforts, in many directions leading to waste of time, money, and energy. District technical schools should be opened within

given areas, or a technical side to existing schools be developed; or, perhaps better still, the schools of the whole district should be affiliated, with a technical school attached, for the use of the pupils from all. The money received by county councils for the technical education grant might be well spent in equipping such schools. If a plot of land could be attached to the technical schools, it would be very useful for the purpose of experiment and demonstration in the field.

At the close of a discussion, the Chairman said Lady Warwick's paper was so full of suggestions that it was impossible to comment upon them briefly. It involved educational reforms of the highest importance, and the first was that one public authority in each district should see that education was properly carried out. Lady Warwick had put aside the utilitarian view; nevertheless, this was a subject of considerable moment, both in town and country. Denmark was far ahead of us in agricultural matters, and sent to this country produce to the value of 10,000,000*l.* annually. It was an extraordinary thing that we should have to pay enormous sums of money to foreign countries for supplies which we ought to be able to provide much better at home. They were told that foreigners were more intelligent than our people; and although he did not believe that, we should educate our people and try to make them as intelligent, fruitful, and productive as their foreign competitors.

A large number of other papers were read before the Congress, but the limitations of space prevent us from referring to them.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Bacteria and the decomposition of rocks, by J. C. Branner. In criticism of the somewhat largely prevailing idea that bacteria are the cause of much of what is called the decay of rocks, it must be remembered that nitrifying bacteria not only do not penetrate the rocks themselves to any considerable depth, but they do not even penetrate the soil to a depth of more than three or four feet. Granites are, on the other hand, often decomposed to depths of more than 100 feet.—On Wellsite, a new mineral, by J. H. Pratt and H. W. Foote. This mineral occurs at the Buck Creek corundum mine in Clay Co., North Carolina, associated with albite, feldspar, and hornblende. No crystals found exceed 2 mm. in length. They are monoclinic and twinned, brittle, with a vitreous lustre and no apparent cleavage. They are colourless and transparent or white, with a hardness of between 4 and 4.5, and a density of about 2.3. Chemically, it is a barium or calcium hydrated silicate corresponding to the formula $\text{RAH}_2\text{Si}_3\text{O}_{10} \cdot 3\text{H}_2\text{O}$, and is therefore allied to Phillipsite, harmotome, and stilbite.—The magnetic increment of rigidity in strong fields, by H. D. Day. The author employs extremely strong fields in order to bring out clearly the relation between magnetisation and the phenomena of magnetic rigidity. He shows that long after magnetic saturation has been reached the increase of rigidity due to increase of field intensity goes on, and that the limit of the latter is not reached even with the highest field intensities attainable. As the field becomes stronger, the increment of rigidity varies more and more regularly with the twist, the tendency being that in fields indefinitely large the increment of rigidity would be proportional to the twist applied.—The broadening of the sodium lines by intense magnetic fields, by A. St. C. Dunstan, M. E. Rice, and C. A. Kraus. The phenomenon of the magnetic broadening of the sodium lines discovered by Zeemann may be easily observed with the aid of Michelson's interferometer. Light from a Bunsen flame containing a sodium salt is sent on to a plate of plane glass which partly reflects and partly transmits it to a fixed and a movable mirror. The fringes produced in the telescope by their recombination are made less visible by the broadening of the line observed. The curve of visibility gives the amount of the broadening. In the most intense field the broadening is in the ratio of 1 to 1.7. It is proportional to the field intensity.—The relative motion of the earth and the ether, by A. A. Michelson. This was investigated by an interference experiment in which a beam of light was made to travel round a rectangle in a vertical E. and W. plane, and to return along the same path. If the ether near the earth's surface moves with the earth, and the ether above the atmosphere is stationary, there must be some difference of

velocity in the upper and lower paths, which would be indicated by a displacement of the fringes. No such displacement is observed, and hence we must conclude that either the ether is absolutely at rest everywhere, or that the earth drags it with it up to many thousand miles from the surface, or, lastly, that the length of all bodies is altered by their motion through the ether.

Bulletin of the American Mathematical Society, May.—Systems of continuous and discontinuous simple groups, by Dr. L. E. Dickson (read at the April meeting of the Society). This paper is in continuation of some results announced at the Buffalo meeting (August 31, 1896), and consists of four sections. § 1 enumerates the known systems of discontinuous simple groups; § 2 the systems of finite continuous transformation groups which are simple; § 3 gives an elementary deduction of certain groups in § 2, viz. the groups in the $(2l+1)$ parameters, isomorphic with the general projective group of a linear complex in R_{2l-1} , and a proof of their simplicity; § 4 discusses the semi-simple linear homogeneous groups whose defining function is the sum of n determinants of order $q > 2$. The contents of §§ 3, 4 were presented by Prof. Lie (February 19) to his class, and he stated that “the interesting result of § 4 was new, and not what one would have expected.”—On the number of roots of the hypergeometric series between zero and one by Mr. M. B. Porter (read at the March meeting). Klein’s solution was published in 1890 (*Math. Ann.*, vol. xxxvii.). Solutions by Hurwitz and Gegenbauer are given in the *Math. Ann.* (vol. xxxviii.) and the *Wiener Sitzungsberichte* (vol. c.^{2a}) respectively. The object of the present paper is to apply two theorems of Sturm (*Liouville’s Journal*, vol. i.) to the solution of the problem.—Another paper, read at the March meeting, is by Prof. J. Pierpont on modular functions. This treats the subject from the point of view of H. Weber’s Memoir, zur theorie der Elliptischen Functionen (*Acta Math.*, vol. vi. p. 329; cf. also his Elliptische Functionen und Algebraische Zahlen, 1891).—In the Notes are given the mathematical courses for the summer session at the Universities of Chicago, Leipzig, and Munich.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 1.—Contributions to the knowledge of the Urticaceæ and the Moraceæ, by M. Golenkin, with one plate. The inflorescence and the disposition of leaves are treated in this second instalment (in German).—A preliminary catalogue of the Lepidoptera of the province of Kazan, by L. Krulikovski, continued (in Russian).—Study of the embryonal development of *Gammarus pulex*, by Marie Rossyskaia-Kojevnikova, with one plate (in French).—Materials for the mycological fauna of the province of Smolensk, by A. Jaczewski (in French). The author has found in that province 550 species of fungi, out of which 408 are new for that region, and he gives the list of these species.—On the structure, function and evolution of the Nematocysts of Coelenterata, by N. Iwanzoff, with four plates (in German). An elaborate work, made at the zoological laboratories of Naples and Villefranche, to be continued.—On the rotation of the earth, supposed to be fluid in its interior, by Prof. Th. Sloudsky, being a purely mathematical inquiry, continued from a previous number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—“A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media.” By Joseph Larmor, F.R.S., Fellow of St. John’s College, Cambridge. Received April 21.

This series of papers is mainly concerned with the development of electrical and optical theory on the basis that electricity is constituted of discrete atomic charges or electrons. It has been shown in the previous papers that the facts of electrodynamics require this hypothesis and are consistent with it. The hypothesis was arrived at from the point of view of the properties of the æther, the conception of the electron as a permanent strain-centre being a necessary feature of a theory of an elastic æther. This idea is here developed and illustrated by aid of a specification, on Lord Kelvin’s lines, of a gyrostatic material structure which would possess the rotational elasticity characteristic of the æther, and at the same time contain such strain-centres. The conception of a medium of elastic solid type containing mobile discrete strain-centres is also touched upon, by way of illustration and contrast.

In the previous papers the relations of electromotive and optical phenomena in matter at rest had been developed on this basis. When the matter is considered as in motion through the æther, or when electric forces on matter are treated, we obtain a definite and sufficient basis of connection between matter and æther by assuming that the electrons are attached to the atoms of matter. On this basis the electric and optical relations of moving material media are here developed at length. The more speculative question, as to how far a constitution of the material atom which makes it consist wholly of a system of electrons describing orbits round each other suffices to represent or illustrate the properties of matter, comes under consideration in various respects: this hypothesis in many of its features would agree with the well-known theory of vortex atoms.

The theory of refraction equivalents is developed, leading to Lorentz’s results. The theory of optical dispersion is treated from the generalised standpoint that the molecule vibrates about a configuration of steady motion instead of one of rest: it appears, also, that the formula usually given for the square of the refractive index must be replaced by a similar formula for the Lorentz refraction equivalent.

The character of the mechanical forces that are developed in fluid and solid material media by the electric attractions between the polarised molecules of which they are composed, is considered, and expressions are obtained for them. A distinction is here essential between those forces between neighbouring molecules which are compensated locally, and the ones which give rise to transmitted mechanical force which must be compensated by regular mechanical stress in the medium; somewhat in the manner of the corresponding distinction employed by Young and Poisson in the theory of capillarity. It leads, through the negation of the perpetual motion, to the specification of a function which is the *mechanical or organised* energy of the material medium: this is different from the *available or free* energy of thermodynamics, which is also represented by an analytical function on account of the negation of the unlimited availability of diffuse thermal energy: it is, of course, also different from the *total or aggregate* energy of the molecules of the medium, about which little can be known in detail. The theory of osmotic forces is formulated in relation to the available energy with which they are connected, as they are related to the individual molecules sifted by porous partitions, and not to the element of matter in bulk: the known general laws of chemical equilibrium are formulated as corollaries to the same principle. On the other hand, the mechanical forces in a fluid molecular medium polarised in any manner are expressed in terms of the distribution of *mechanical* energy of polarisation. The doctrine of *energetics* (including the conception of temperature), which forms a sufficient basis for the descriptive explanation of the mechanics of statical or steady material systems, thus reposes on the negation of the two types of perpetual motion above mentioned, and therefore ultimately on the discrete constitution of matter.

A thermodynamic application which possesses interest, both from the light it throws on the nature of magnetism and from the circumstances that in it the heat supply is calculated indirectly from the magnetic energy that runs down, is the relation between magnetic susceptibility and temperature in substances not in the very susceptible or ferromagnetic condition. According to the Weberian theory, which fits in with the present view, diamagnetic energy which is not compensated mechanically goes to the induction of Amperean currents in the molecules; while paramagnetic energy not thus compensated goes to orientating the molecules, and thus into heat. It follows that the diamagnetic coefficient is independent of temperature: on the other hand, it is shown that the paramagnetic coefficient should vary inversely as the absolute temperature. These laws were discovered experimentally by Curie, who finds from a very extensive investigation that they have the same order of accuracy at sufficiently high temperatures as the ordinary gaseous laws: at lower temperatures and in ferromagnetic substances the control of the polarised molecules arises in appreciable part from the magnetic interaction of their neighbours, thus vitiating the law as well as introducing effects of hysteresis. The well-known model of Ewing would thus represent an ideal perfect ferromagnetic in which the control arises wholly from the latter cause.

In application of the previous results as to how far physical actions can be considered as transmitted across the æther by elastic stress, the conditions are formulated under which the